Hydrographic Surveys Multibeam Echosounder Calibration Report

Calibration Date: February 18 and 21, 2004

Ship	NOAA Ship Nancy Foster
Vessel	
Echosounder System	Reson 8101
Positioning System	Trimble DSM212L GPS receiver
Attitude System	Ixsea Octans Gyrocompass & integral motion sensor

Calibration type:

Annual		Full	
Installation	X	Limited/Verification	
System change			
Periodic/QC			
Other:			

The following calibration report documents procedures used to measure and adjust sensor biases and offsets for multibeam echosounder systems. Calibration must be conducted A) prior to CY survey data acquisition B) after installation of echosounder, position and vessel attitude equipment C) after changes to equipment installation or acquisition systems D) whenever the Hydrographer suspects incorrect calibration results. The Hydrographer shall periodically demonstrate that calibration correctors are valid for appropriate vessels and that data quality meets survey requirements. In the event the Hydrographer determines these correctors are no longer valid, or any part of the echosounder system configuration is changed or damaged, the Hydrographer must conduct new system calibrations.

Multibeam echosounder calibrations must be designed carefully and individually in consideration of systems, vessel, location, environmental conditions and survey requirements. The calibration procedure should determine or verify system offsets and calibration correctors (residual system biases) for draft (static and dynamic), horizontal position control (DGPS), navigation timing error, heading, roll, and pitch. Standard calibration patch test procedures are described in *Field Procedures for the Calibration of Multibeam Echo-sounding Systems*, by André Godin (Documented in Chapter 17 of the Caris HIPS/SIPS 5.3 User Manual, 2003). Additional information is provided in *POS/MV Model 320 Ver 3 System Manual* (10/2003), Appendix F, Patch Test, and the NOAA Field Procedures Manual (FPM, 2003). **The patch test method only corrects very basic alignment biases**. These procedures are used to measure static navigation timing error, transducer pitch offset, transducer roll offset, and transducer azimuth offset (yaw). Dynamic and reference frame biases can be investigated using a reference surface.

Pre-calibration Survey Information

Reference Frame Survey
(IMU, sensor, GPS antenna offsets and rotation with respect to vessel reference frame)

Vessel reference frame defined with respect to:

☐ IMU ☒ Reference Position

Reference to IMU Lever Arm

X(m)	Y(m)	Z(m)
1.24	18.31	0

IMU frame wrt vessel reference frame
Reference to Sensor Lever Arm

X(m)	Y(m)	Z(m)
6.50	-3.20	3.44

☐ **Measurements verified for this calibration.**

☒ **Drawing and table attached.**

☐ **Drawing and table included with project report/DAPR:**

Position/Motion Sensor Calibration (for Ixsea Octans Gyrocompass)

Calibration date: 11/15/2000

Reference to primary GPS Lever Arm

X(m)	Y(m)	Z(m)
-0.76	2.54	-4.24

Heave Settings: Bandwidth up to 100Hz Damping Period auto

Firmware version 3.2 was used on DN 49. The system was upgraded to version 4.6 on DN 51, which was used for the remainder of the survey. No lever arm offsets were entered into the Octans.

Static Draft Survey
(Vessel waterline with respect to vessel reference frame)

Survey date: 2/18/2004

On DN 49 while alongside in Frederiksted the vessel took on fuel and water. The transducer draft measurement (z-value for Swath 1) in the VCF was based on a fully loaded vessel. The pole mounting the sonar was marked off in decimeter graduations from the transducer face. This allowed the Hydrographer to determine, to within a centimeter or two, the waterline setting. Readings of the waterline were observed when the pole was deployed. Post fueling, the draft of the Reson sonar unit measured 3.44 meters, and the distance from the waterline to RP measured 1.87 meters. This showed a difference of .127 meters lower in the water prior to taking on fuel and water. Waterline corrector values were added into the vessel configuration file is CARIS.

Static Draft Correction [ ] **(meters)**

Dynamic Draft Survey

(Vessel waterline with respect to vessel reference frame and vessel speed)

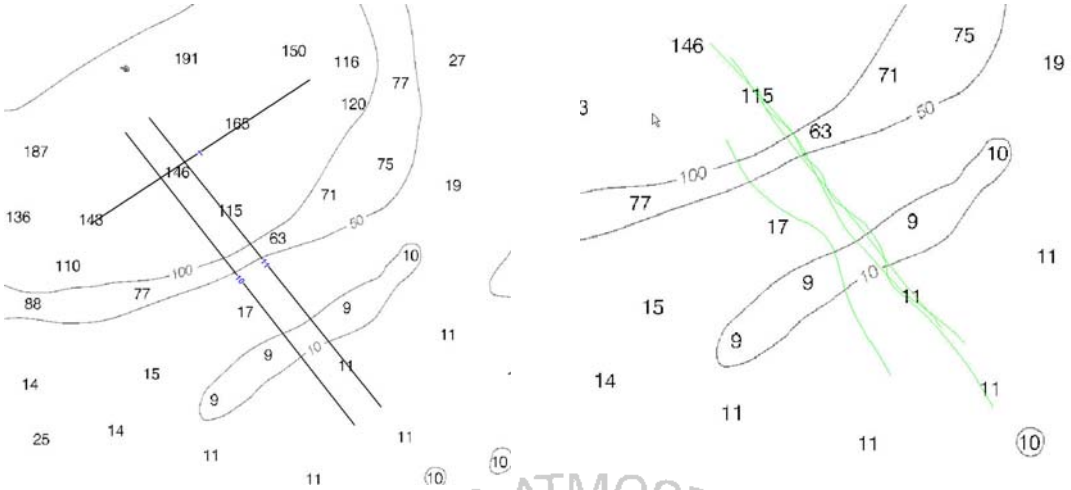
No dynamic draft survey was conducted for this vessel.

Calibration Area

Site Description

On February 18, 2004 prior to the start of survey operations a comparison between the multibeam and single beam systems was conducted alongside the pier in Old San Juan, PR. The ships single beam sonar (Abyss IES-10) measured a depth of 25.2 ft., and the multibeam nadir beam measured 24.7 ft. The estimated draft of the ships singlebeam transducer was 10 ft. The measured draft of the multibeam unit was 11 ft 2 inches. The calculated comparison was 35.2 ft (SB) – 35.9 ft (MB) = a difference of 0.7 ft. This general agreement gave the Lead Hydrographer, at least some confidence in the multibeams proper installation and operation. A more detailed comparison was not possible due to the not knowing the actual draft of the ships single beam transducer.

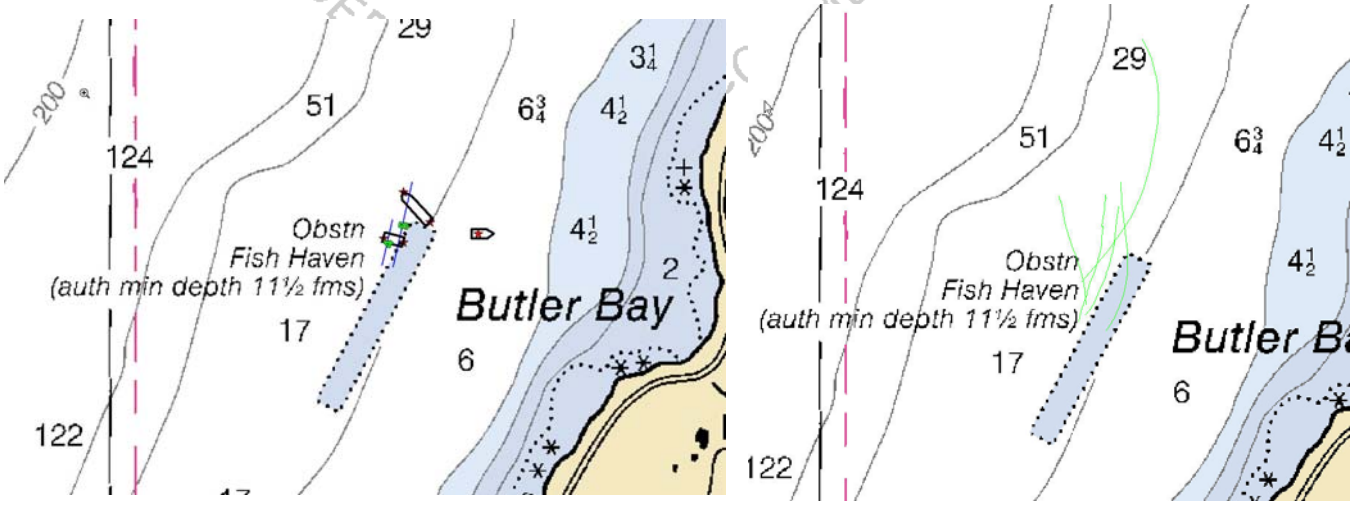
The Nancy Foster patch test was started on February 18, 2004 (DN 49) at 17°39'32.27" N 064°55'06.92" W; (296475.05, 1953489.27), south west of Frederiksted, St. Croix. Water depths at the site ranged from 17-256 meters. The bathymetry of the site consisted of two main components. The first was a steep slope (75 deg) in water depths ranging from 57-174 meters. The second was a relatively flat area, with depths of approximately 20 meters. A successful patch test was not able to be conducted due to several factors including site selection (the water depths exceeding sonar system limitations), lack of time to run all the lines, and the vessel not being on line due to helm/OOD inexperience. Despite this lines run on DN 49 were deemed sufficient to determine the roll bias error. All other values were determined using later patch test data.



DN 49 Patch Site

Between February 18 and resumption of the patch test on the 21$_{st}$ the Nancy Foster was tied up along side in Frederiksted. During this time the patch test data collected on DN 49 was evaluated, and vessel measurements obtained. In addition, the OCTANS was upgraded with a new firmware version (V.4.6) that provided the unit with a real-time self adjusting heave filter.

On February 21, 2004 (DN 52) the patch test was continued at a site north west of Frederiksted, at 17°45'05.39" N 064°53'44.55" W; (299006.21 , 1963706.41). The patch test was conducted on the site of a charted fish haven. The bathymetry of the site consisted of a gently sloping bottom (7.5 degree slope), in water depths ranging from 15-30 meters. Three prominent and one minor wrecks were located with the patch test site. Data acquisition during the patch test was complicated by the vessel again having difficulties staying on line, the general shoal nature of the patch test site, and time constraints due to the vessel needing to begin dive operations.



DN 52 Patch Site

Site and Line Diagram

[X] Submarine Feature

Line(s)	Position	Depth	Description
052-1353 052-1400 052-1412 052-1427	17 45 04.45 N 064 53 45.98 W	18 M	Barge (60 x 17 x 3.5 M)
052-1353 052-1400 052-1412 052-1427	17 45 06.22 N 064 53 44.46 W	17 M	Wreck 1 (40 x 7 x 3 M)
052-1412	17 45 10.20 N 064 53 43.71 W	26 M	Wreck 2 (56 x 13 x 4.6 M)
052-1412	17 45 09.91 N 064 53 42.62 W	17 M	Wreck 3 (26.5 x 7.5 x 4 M)

Calibration Lines

Hypack Line	Caris Line	Azimuth	Speed	Correction				
				Yaw	Pitch	Timing	Roll	Transducer
11	049-0024	141	4.5				X	1
11	049-0036	321	4.5				X	1
5	052-1353	17	2		X	X		1
5	052-1400	197	2		X			1
5	052-1412	197	6	X		X		1
5	052-1427	17	6	X		X		1
4	052-1435	197	2					1
5	052-1353	17	2	X				1

[X] **Copy of acquisition logs attached.**

Sound Velocity Correction

Measure water sound velocity (SV) prior to survey operations in the immediate vicinity of the calibration site. Conduct SV observations as often as necessary to monitor changing conditions and acquire a SV observation at the conclusion of calibration proceedings. If SV measurements are measured at the transducer face, monitor surface SV for changes and record surface SV with profile measurements.

Sound Velocity Measurements

Time	Max. Depth	Surface SV	Change Observed ?	Position	
				Latitude	Longitude
04049150	239.3	1539.2		17^{E} 40’ 01.7” N	064^{E} 55’ 47.7 “W
04520512	190.1	1539.3		17^{E} 44’ 48.0” N	064^{E} 54’ 09.0” W

Tide Correction

Gauge ID 9751639 Charlotte Amalie,VI and 9751401 Lime Tree Bay, VI

Approximate distance of gauge from calibration site: 9 and 40 respectively **(n. mi.)**

Approximate water level range at calibration site: .018 **(meters)**

Water level corrections applied:

[X] Predicted [ ] Verified
[ ] Preliminary
[ ] Zoned Note: Patch was processed using predicted tides, not zoned. Post survey all data was tide corrected using Verified zoned tides.

Data Acquisition and Processing Guidelines

Initially, calibration measurement offsets should be set to zero in vessel configuration files. Static and dynamic draft offsets, inertial measurement unit (IMU) lever arm offsets, and vessel reference frame offsets must be entered in appropriate software applications prior to bias analysis. Perform minimal cleaning to eliminate gross flyers from sounding data.

Navigation Timing Error (NTE)

Measure NTE correction through examination of a profile of the center beams from lines run in the same direction at maximum and minimum vessel speeds. NTE is best observed in shallow water.

Transducer Pitch Offset (TPO)

Apply NTE correction. Measure TPO correction through examination of a profile of the center beams from lines run up and down a bounded slope or across a conspicuous feature. Acquire data on lines oriented in opposite directions, at the same vessel speed. TPO is best observed in deep water.

Transducer Roll Offset (TRO)

Apply NTE and TPO corrections. Measure the TRO correction through examination of roll on the outer beams across parallel overlapping lines. TRO is best observed over flat terrain in deep water. An additional check for TRO adjustment can be performed by running two lines parallel to a sloped surface.

Transducer Azimuth Offset (TAO or yaw)

Apply NTE, TPO and TRO corrections. Measure TAO correction through examination of a conspicuous topographic feature observed on the outer beams of lines run in opposite directions.

Patch Test Results and Correctors

Evaluator	NTE (sec)	TPO (deg)	TAO (deg)	TRO (deg)
Rooney	0.0	-3.6	-2.4	+0.25
Final Values	**0.0**	**-3.6**	**-2.4**	**-0.9**

Corrections calculated in:

[X] Caris [ ] ISIS

[ ] Other _____

Caris Vessel Configuration File

Name: Nancy Foster

Version: 5.3 Sp 3 hot fix 25

New [X] Appended values with time [ ] tag

Comments:

A 1 meter artifact was observed during main scheme data acquisition. The source of the artifact could not be determined during the survey, possible sources include an improper setting in the Octans gyrocompass, or a miss measured lever arm.

Additional calibration or action recommended:

The patch test data will be forwarded to Gerd Glang at UNH for further review.

Evaluator: Sean Rooney

Reviewed by: _____

Accepted by: _____